CONFIDENTIAL

SECRET

Encl. #1 to
SAPC 23892
COPY 1 OF 4

TERRAIN AVOIDANCE RADAR

WESTINGHOUSE ELECTRIC CORPORATION
Air Arm Division
Baltimore, Maryland

1 January 1958

NOTICE: This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793-794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

CONFIDENTIAL

SECRET

This brochure contains information of a patent or proprietary nature; therefore, all recipients are liable for the unauthorized use or disclosure of any part thereof without the express written permission of Westinghouse Electric Corporation.

OUTLINE OF BROCHURE

TERRAIN AVOIDANCE RADAR

ILLUSTRATIONS

SECRET

INTRODUCTION

This brochure presents a brief introduction to Westinghouse Terrain Avoidance Radar Systems. Since 1952, Westinghouse Air Arm Division has developed and flight-tested several systems designed for aircraft with a mission requirement of low-altitude flight in either darkness or adverse weather.

Flight tests have proven the feasibility of a three-dimensional system of presentation. At present, development is progressing on an advanced version of the Terrain Avoidance Radar Featuring greatly increased capabilities and significant reduction in size and weight over early flight test models. It is contemplated that the flight test of this model will be conducted at Air Arm Division in the near future.

LOW ALTITUDE MISSIONS

With the rapid growth of ground-based, long-range radar and IR installations, low-altitude approaches and penetrations have become increasingly important as a means of avoiding detection over enemy territory.

The probability of survival increases as altitude decreases, with an increasingly more than proportionate benefit as the flight path drops below 500 feet. Maximum security can be achieved by following valleys or flight paths behind concealing ridges. This also minimizes the effectiveness of electronic countermeasures by the enemy.

Low Altitude Reconnaissance

Low-level approach to enemy territory from the sea can be made with greater security from detection if a terrain avoidance system is utilized to give the pilot a good landfall presentation in azimuth as well as in elevation. With this three-dimensional information, a flight path near wave-top level is possible right up to the shore line. Subsequent reconnaissance can then be carried out at low altitude, taking advantage of protective topography where available.

Toss Bombing

The advantages of utilizing toss-bombing techniques can be effectively supplemented by low-level approaches prior to the toss maneuver. An effective terrain avoidance system can provide greater probability of escape.

Support

Missions which require the delivery of manpower and supplies near front line areas may be made with greater safety in the dark of night and obscured from enemy radar by concealing ridges.

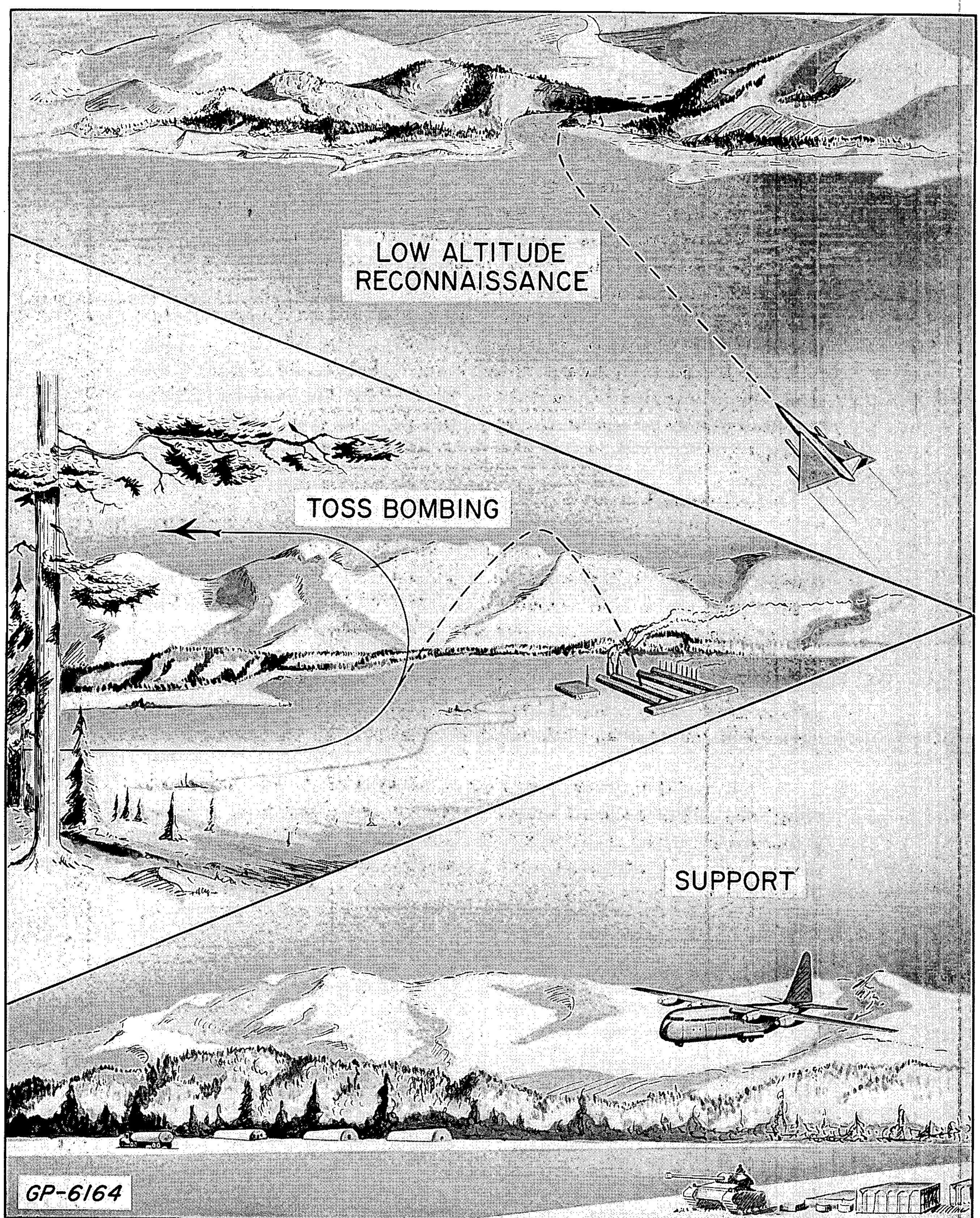

Figure 1. Low Altitude Missions

RADAR INDICATION

The method of presentation used in the Westinghouse Terrain Avoidance Radar was selected as a result of an extensive study of the problem, plus numerous discussions with military personnel and pilots who had first-hand knowledge of the operational requirements. The objective is to provide information requiring the minimum amount of pilot interpretation in order to reduce response time and the chance for error. Pilot procedures for mission accomplishment are generally the same as those followed under visual daylight conditions. The indicator simulates the view which the pilot would normally see through his windshield; i.e., elevation angles vs azimuth angle related to the aircraft as the point of viewing.

Scanning Method

The radar scans a sector ahead of the plane. This sector is 30 degrees wide and 10 degrees thick, vertically. A 2–degree pencil beam scans this sector with a horizontal scan rate of 23 lines per second. Vertical scanning is at a rate of approximately 2 frames per second.

The third dimension is presented by color-gating the signal returns into three color segments – red for near, yellow for intermediate, and green for distant targets, out to maximum range.

A "white" storage-type cathode ray tube is used in conjunction with a red and green filter system to produce color images on a ground glass viewing screen. Two scanning rasters on the cathode ray tube provide images of red and green while an appropriate amount of time-sharing provides the yellow image where the red and green overlap.

CONFIDENTIAL

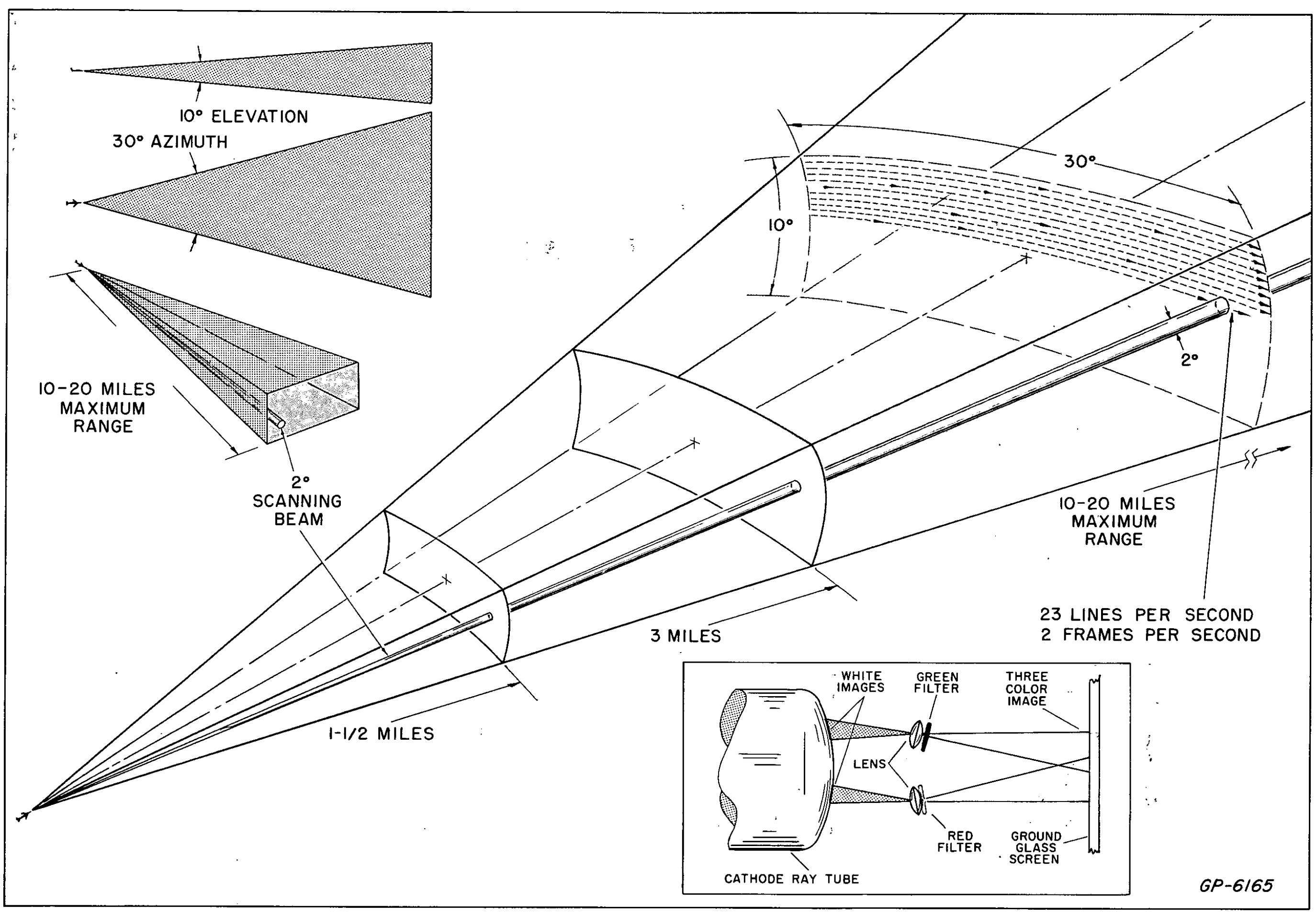

Figure 2. Scanning Method

Air Arm Westinghouse

CONFIDENTIAL

X–Scope Indicator

By superimposing the scan sector on a section of terrain, the corresponding indicator presentation is illustrated. The color contours correspond to the terrain contours within the various color segments.

The "wings" at the center indicate the aircraft heading in relation to the radar picture. The radar presentation is natural, requiring no mental transposition by the pilot. This ensures maximum speed of recognition with minimum chance of error in interpretation.

The illustration shows in "static" form the presentation available to the pilot, but in actual operation the pilot also perceives "rate" information as the target contours progressively pass through the color sequence. Any lateral drift of the plane due to crosswind is similarly apparent as a gradual drift of the radar picture, analagous to the drift observed optically through the windshield under visual flight conditions.

The red and yellow segment limits are arbitrarily illustrated as 1½ and 3 miles. These limits can be preset to other values to suit the speed and maneuverability characteristics of a particular aircraft.

A pattern of lines across the indicator is tied in to a vertical reference and thus serves to indicate aircraft roll attitude. These will remain parallel to the horizon and keep track of roll altitude even in severe nose-up maneuvers where no ground return shows on the indicator.

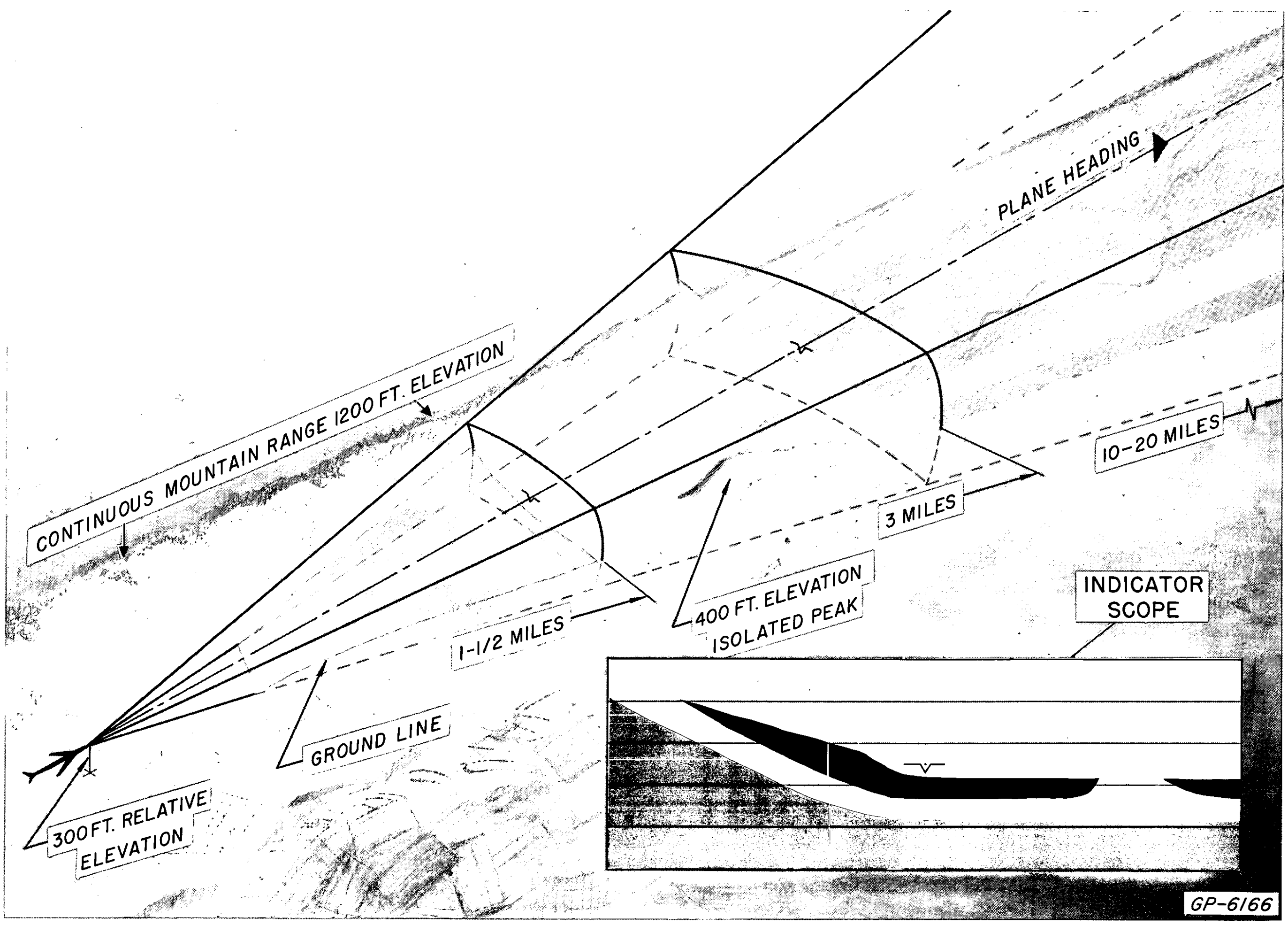

Figure 3. Transverse Profile Indication (X–Scope)

E–Scope Indicator

The E–scope is an auxiliary indicator which presents a longitudinal profile of terrain ahead of the aircraft. All radar signal information required by this indicator is contained within the signals processed by the X–scope system. By electronically selecting the signal return along a narrow vertical section, a profile of the terrain intersected by that section can be provided. Furthermore, the terrain profile displayed can be chosen at will, anywhere within the 30-degree scan sector of the antenna system.

This provides the advantages of detail range and elevation information normally presented by profilometer systems with the additional feature of providing a choice of profile over a 30-degree angle without changing aircraft heading. The position of the selected profile section is indicated by a thin vertical trace on the X–scope transverse profile presentation.

Across the top of the E–scope a luminous line indicates altitude of the plane above ground. This is calibrated to 1000 feet and derives its signal from a portion of the radar signal directed at the ground below.

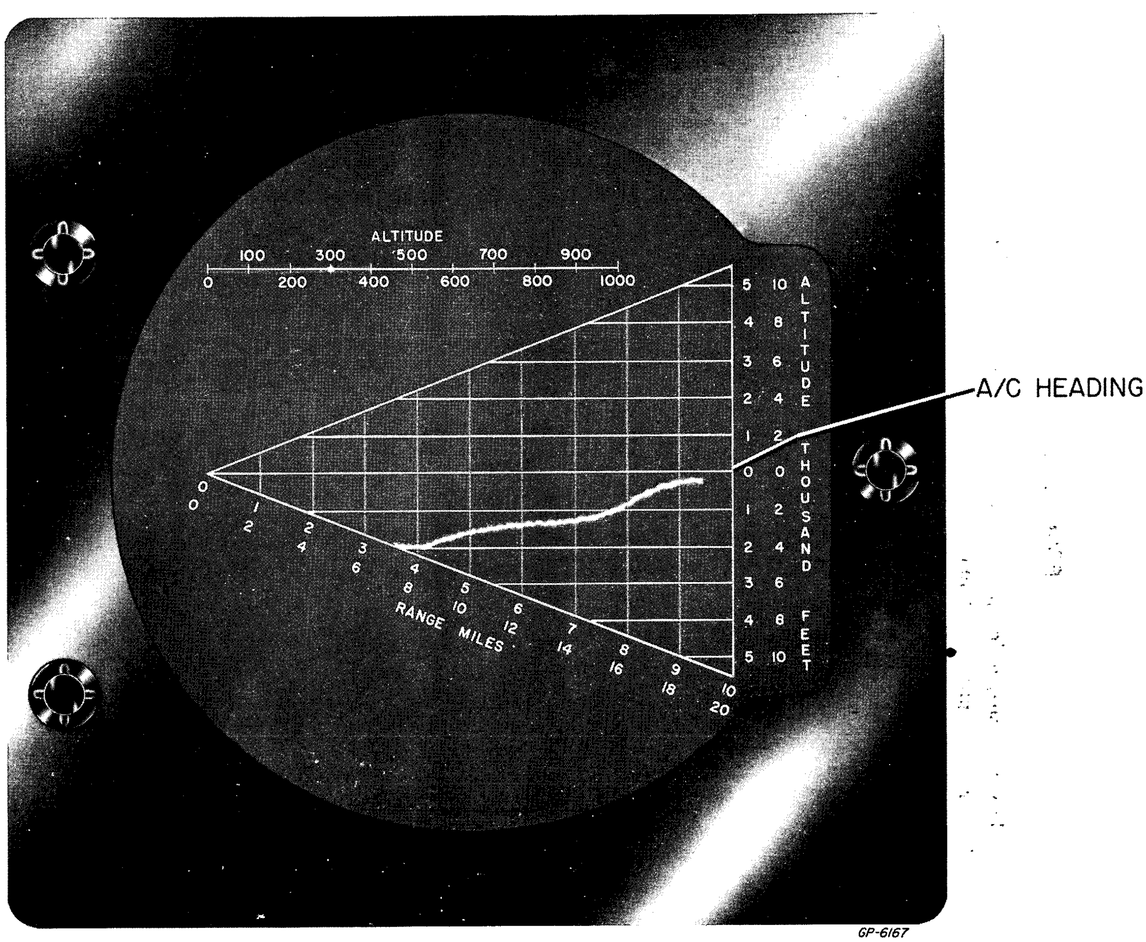

Figure 4. Longitudinal Profile Indication (E–Scope)

Air Arm Westinghouse

Declassified and Approved For Release 2011/12/06 : CIA-RDP89B00709R000400890017-0

EQUIPMENT

The X–Scope, which presents a transverse profile, is the principal indicator for the pilot during low-altitude maneuvers.

The E–Scope, which presents a longitudinal profile, is an auxiliary indicator to provide additional useful information and is particularly recommended where a navigator is employed.

Declassified and Approved For Release 2011/12/06 : CIA-RDP89B00709R000400890017-0

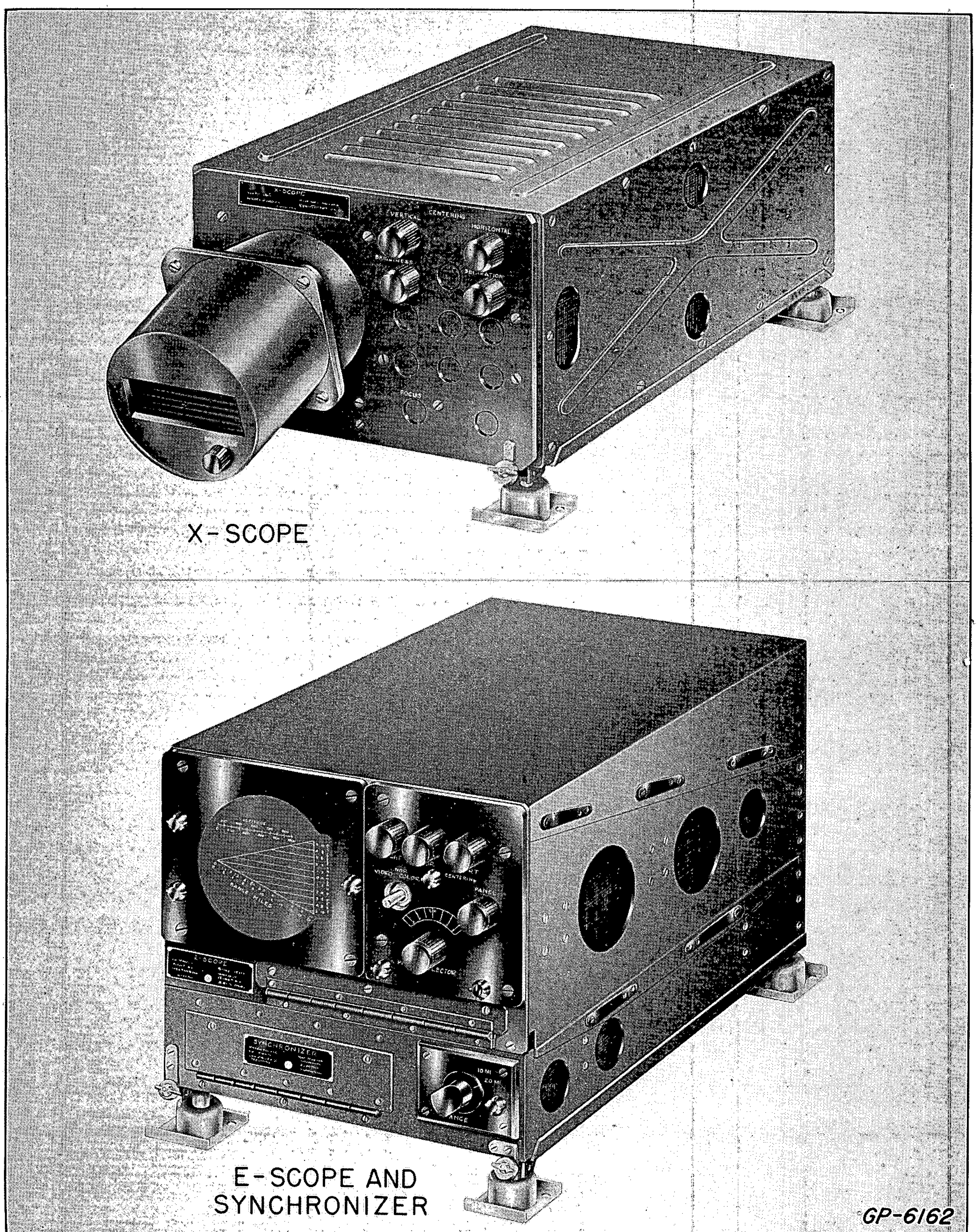

Figure 5. X–Scope and E–Scope

Antenna and R–T Unit

The antenna installation with the receiver-transmitter and the modulator can be mounted in any position affording a forward view and a space of 23 inches in diameter and 36 inches long; however, the mounting must be in a position which is not subject to undue angular distortion.

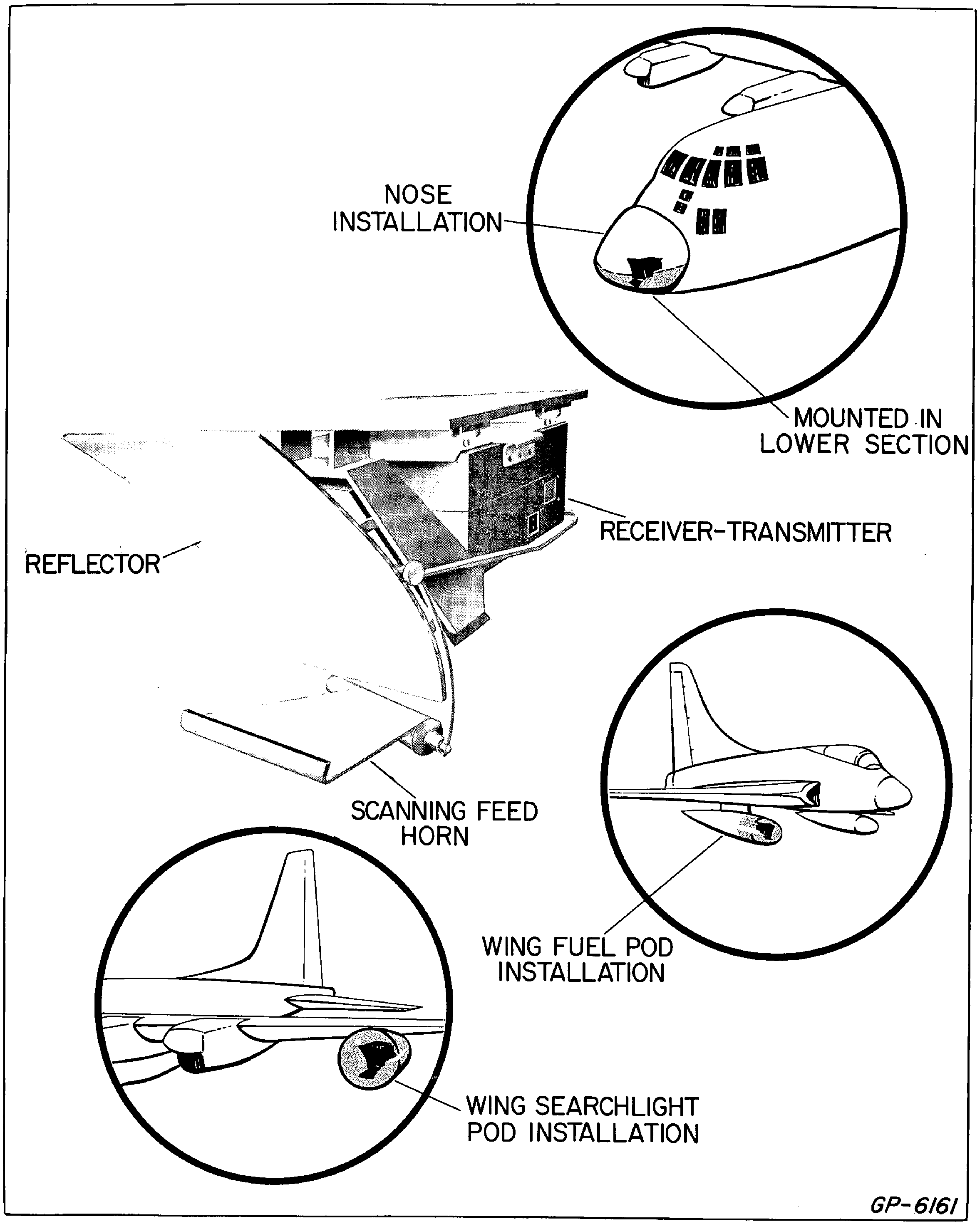

Figure 6. Antenna and Receiver–Transmitter

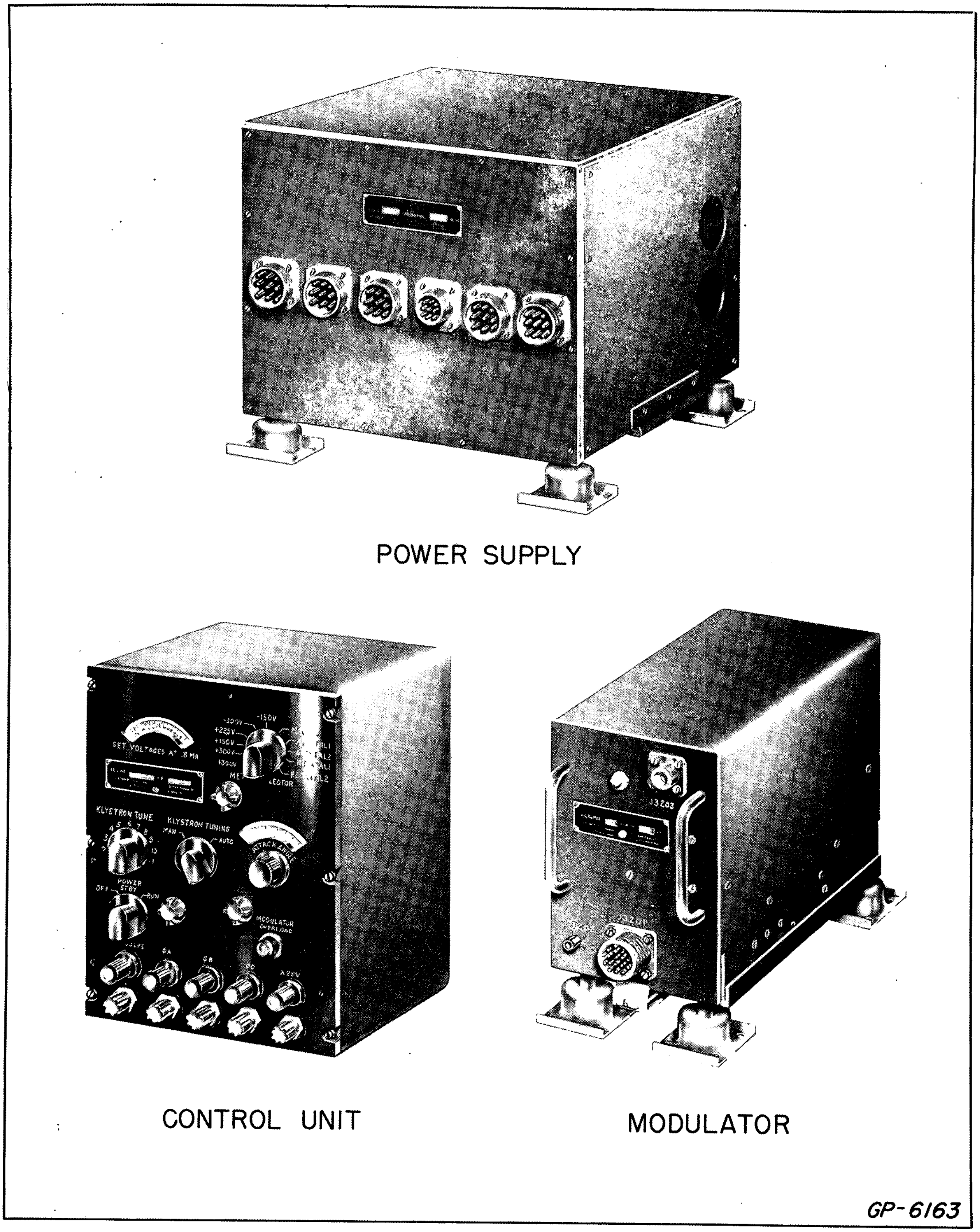

Figure 7. Power Supply, Control, Modulator

Size and Weight

SINGLE INDICATOR (PILOT)

	EQUIPMENT	DIMENSIONS W-H-D (INCHES)	VOLUME CU. FT.	WEIGHT LBS
1	ANTENNA	16 x 16 x 12	1.78	42
2	RECEIVER-TRANSMITTER	11-1/8 x 9 x 11	.64	30
3	MODULATOR	9 x 6 x 7	.22	12
4	POWER SUPPLY	15 x 11-1/4 x 15-1/2	1.52	20
5	SYNCHRONIZER	12 x 3-5/8 x 18	.45	10
6	CONTROL	8 x 10-7/8 x 8	.41	10
7	X-SCOPE (TRANSVERSE PROFILE) OPTICAL HEAD	10 x 8 x 19-1/2 6 x 6 x 8	1.03	25
	TOTAL SYSTEM		6.05 CU. FT.	149 LBS

MULTIPLE INDICATOR (PILOT AND NAVIGATOR)

	EQUIPMENT	DIMENSIONS W-H-D (INCHES)	VOLUME CU. FT.	WEIGHT LBS
1	ANTENNA	16 x 16 x 12	1.78	42
2	RECEIVER - TRANSMITTER	11-1/8 x 9 x 11	.64	30
3	MODULATOR	9 x 6 x 7	.22	12
4	POWER SUPPLY	15 x 11-1/4 x 15-1/2	1.52	20
5	SYNCHRONIZER	12 x 3-5/8 x 18	.45	10
6	CONTROL	8 x 10-7/8 x 8	.41	10
7	X-SCOPE (TRANSVERSE PROFILE) OPTICAL HEAD	10 x 8 x 19-1/2 6 x 6 x 8	1.03	25
8	AUXILIARY X-SCOPE (FOR NAVIGATOR) OPTICAL HEAD	10 x 8 x 19-1/2 6 x 6 x 8	1.03	25
9	E-SCOPE (FOR NAVIGATOR)	12 x 8-1/2 x 18	1.06	20
	TOTAL SYSTEM		8.14 CU. FT.	194 LBS

GT-13818

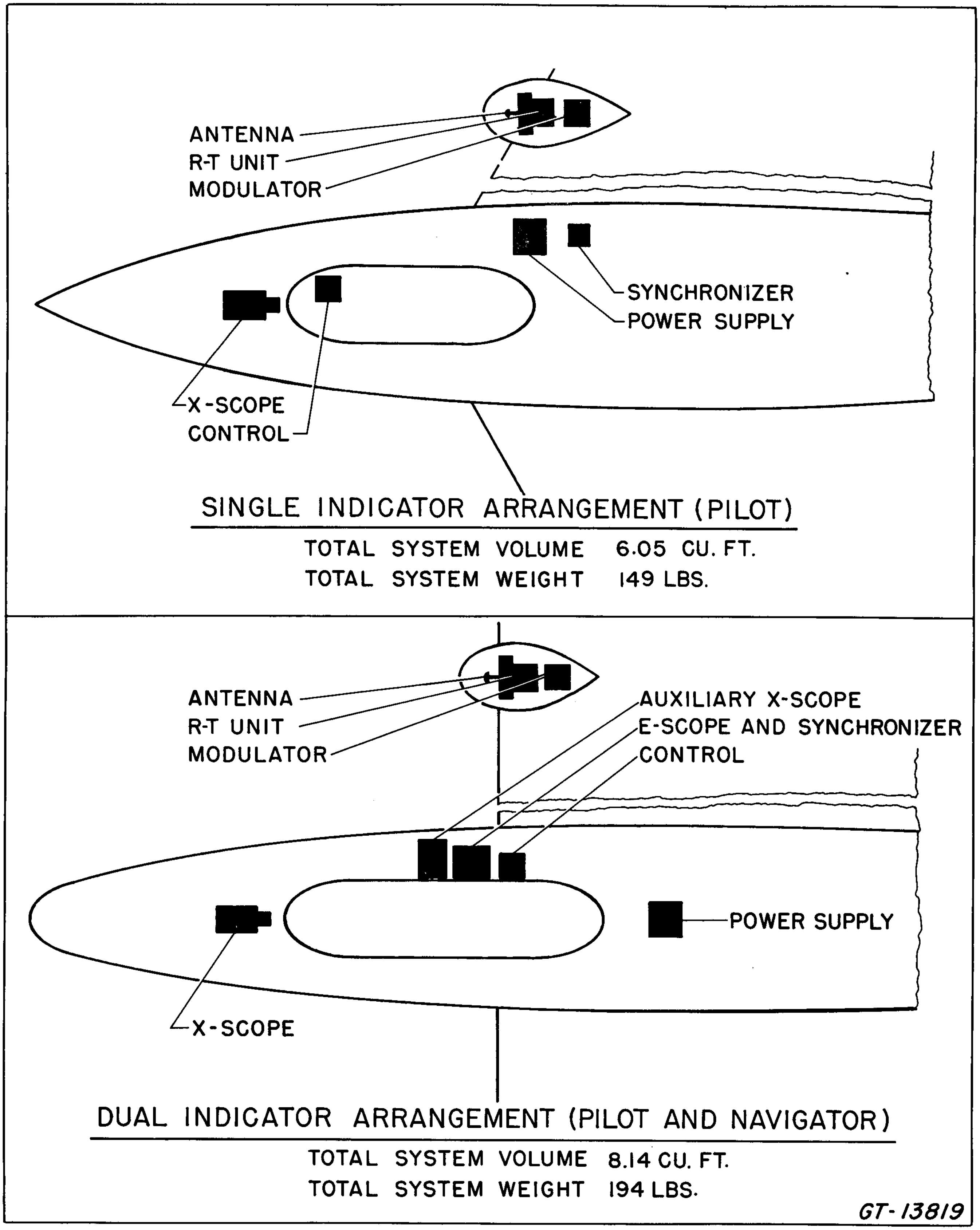

Figure 8. System Configurations

SUMMARY OF SYSTEM CHARACTERISTICS

Antenna

Beamwidth

Pencil Beam	2 degrees

Scan Sector

Vertical	10 degrees
Horizontal	30 degrees

Scan Rate

Horizontal Lines	23 per second
Frames	2 per second

Attack Angle Adjustment

5 degrees Manually Adjustable at Control Unit

Declassified and Approved For Release 2011/12/06 : CIA-RDP89B00709R000400890017-0

Transmitter

Magnetron Type	MA 207
Frequency	34,900 ± 350 Mc
Power	60 Kw peak
Pulse Length	0.25 microseconds
Prf	1365 pulses per second

Receiver

System noise figure	12.5 db
Receiver gain	91. db
IF frequency	45. Mc
Bandwidth	4.2 Mc
Local Oscillator	VA–97 Klystron
Tuning	AFC or Manual

Indicator – Transverse Profile (X–Scope)

Presentation	Azimuth vs elevation, 10 x 30 degrees. Three range segments in red, orange, and green.
CRT	RCA C73703B storage tube with selective erase gun.
Marks	Vertical trace to indicate position of longitudinal profile displayed on E–Scope. Lines to indicate aircraft attitude.

Indicator – Longitudinal Profile (E–Scope)

Presentation	Range vs. elevation
Scale	10–mile and 20–mile
CRT	5UP7
Marks	1–mile marks on 10–mile range 2–mile marks on 20–mile range

System

Power Consumption

	28 V DC	80 watts
400 cycle	3 ϕ	1500 watts
	Total	1580 watts